SPACE / DEFENSE CORPORATION
1600 NORTH WOODWARD AVENUE • BIRMINGHAM, MICHIGAN

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Grants and Research Contracts
Office of Space Sciences and Applications
National Aeronautics and Space Administration
Washington, D. C. 20546

Attention: Code SC

Subject: Second Quarterly Status Report

Reference: (a) Contract NASw-870

Enclosures: (1) Second Quarterly Status Report - Contract NASw-870, Period May 4, 1964 to August 14, 1964 (25 copies)

Gentlemen:

In accordance with the provisions of referenced contract, twenty-five copies of subject report are provided herewith.

Sincerely,

SPACE/DEFENSE CORPORATION

Donald L. Foster
Project Manager

DLF/amg

Encs.

TR64-107
August 21, 1964

SECOND QUARTERLY STATUS REPORT
Contract NASw-870
Period May 4, 1964
to August 14, 1964

Prepared for: National Aeronautics and
Space Administration
Washington, D. C. 20546

Prepared by: Donald L. Foster
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I. INTRODUCTION

Under contract No. NASw-870, supported by NASA (Bioscience Programs), Space/Defense Corporation is developing a respirometer and life support system to maintain a potato specimen in the space environment for a period of 90 days. The previous quarterly status report on this contract discussed the preliminary work which had been achieved. During the period of this report substantial advances have been made and we are able to report with greater definition the program progress, discuss technical problems which have been resolved, and present two kinds of technical problem areas looming ahead. The first relates to problems we have delineated, but not yet solved; the second is merely a problem area category in which specific technical problems -- if any exist -- have not yet been identified.

II. PROGRAM STATUS

A. General

During the report period a breadboard respirometer has been completed and testing of the breadboard instrument has been initiated. This progress has not been accomplished without the usual problems normally encountered in the development of a relatively sophisticated system of this type.

The combination oxygen storage bottle and respiratory atmosphere pressure regulator, developed by Carleton Controls Corporation, Buffalo, New York, appears to function satisfactorily following the resolution of an initial problem

ABSTRACT

Work accomplished during the report period under NASw-870 is discussed. Problems solved are reviewed and a major unsolved problem -- data discrimination -- is discussed with some possible solutions presented. Despite the unresolved problem the program is essentially on schedule; however, the effort expended to date is greater than anticipated.

associated with charging the bottle to its operating pressure. Replacement of the fill valve in this unit was required so that the charging bottle could be disconnected without complete loss of system pressure. A second problem arose when a sub-carrier oscillator had not been delivered 90 days after the order and a normal follow-up was initiated with the supplier. This inquiry resulted in the discomforting discovery that our purchase order had apparently been lost during a move by the supplier. Approximately 40 days additional time (over that initially contemplated) was therefore required for the ultimate delivery of this component.

Despite the problems noted above, numerous preliminary tests were conducted. These included a pressure tightness test of the respirometer capsule assembly to confirm that a positive seal could be achieved at the parting surfaces for the specimen retainer assembly and at the carbon dioxide scrubber cap. These seals are obtained through the application of mechanical force to gold O-rings at the sealing surfaces. As a result of these tests, it is now known that a reliable seal can be made with a minimum degree of checkout time required to determine that a positive seal has been achieved. It has also been found that the gold O-rings may be re-used, despite the contrary recommendations made by the manufacturer of these items.

Leakage tests have also been conducted using the complete pressure system. These tests have indicated that the total assembly can be maintained with essentially zero leakage for the 90-day operational period anticipated. Thus, we are

now reasonably confident of the capability for the system to have full pressure integrity throughout the duration of its intended use in space

B. Problem Area Discussion

During the previous quarterly report certain potential problem areas were outlined and they still remain as areas of concern. At the writing of this report the breadboard system, complete with a tuber specimen, is undergoing a laboratory test with a continuous readout of oxygen consumption and capsule pressure. It is premature to assume that the total system is operating perfectly. As far as we can determine at this time, however, all seems to be in order and functioning in the manner expected. Due to the low oxygen consumption, however, it will require a test of (probably) about 30 days before we can determine from the chart records if the system is operating up to expectations.

In view of the above test, and prior component and subsystem testing, we are less concerned about the water supply technique and the semipermeable membrane suitability than we were when the previous quarterly report was written. Therefore, those two problem areas do not presently seem as formidable as they did.

In the other two problem areas outlined in the previous quarterly report we have no additional information. Those two areas included temperature control and power consumption. Both of these areas will be investigated further during the coming period.

Until quite recently we have considered only the utilization of telemetry band 13 for data transmission to determine the oxygen utilization of the potato plug specimen. We recognize that use of this channel may impose some operational problems; therefore, we have also considered telemetry band E. In view of our operational duration requirement of 90 days for data transmission, we have computed that we need to have a four-minute sample of data, but to assure total coverage we must double this sample time. Therefore, for band 13 we will need an 8-minute period of data telemetering per hour for each hour aloft to meet our data requirements. Telemetry band E offers a certain advantage with respect to the actual data sampling time because with band E only 1/10th the sample time will be required. Therefore, for band E, sampling can be accomplished in 48 seconds. Obviously a trade-off analysis is required to examine all the factors involved before making an ultimate selection of the specific telemetry band. Some of the other factors could impinge on other experiments, and other data telemetry requirements, as well as the total available time for sharing information on a particular band. After our preliminary review, however, it is apparent that band E may be a better selection than band 13, but at this point the channel selection tradeoff analysis requires information related to total telemetry requirements for a specific flight system. At this time we are, therefore, unable to make such a determination.

We have encountered one major problem which has not yet been resolved. The problem simply involves the discrimination -- on an hourly basis -- of the actual oxygen consumption of our potato specimen. When all of the information is considered

in detail it turns out that our requirement for data discrimination is one part in 200,000 (5×10^{-6}). Presently this is beyond the capability of the breadboard instrument. Based on the quality of our present data output it would be possible for us to measure -- over a 90-day period -- the average oxygen consumption rate of the specimen. Because of drift currently inherent in the data system, however, it is not presently possible to delineate variations in consumption rate due to rhythmicity.

To resolve the above seemingly straightforward problem, we are attempting to eliminate the signal drift and achieve the resolution which is required. In parallel we are exploring other possible techniques to resolve the problem. We have taken a preliminary look at the technique of employing a gaseous radioisotope tracer to help in acquiring the data we seek. Kr_{85} appears to meet most of the requirements we believe are necessary for a radioisotope tracer gas and it is likely that we will explore this further and attempt some experiments employing this technique. We have no knowledge of the possible biological interaction with the organism and we have not discussed this with any of the Northwestern scientists. Even if there is an interaction, so that an additional "noise" is introduced to the potato specimen, it is recognized that the space experiment packages and ground control packages would be equally affected. Therefore, the effect should cancel so that the true result of the space environment influence should be determined just as easily whether there is or is not a radioisotope tracer gas contaminating the potato plug's oxygen supply.

At this time we do not have an answer for the problem of data resolution, but we should know relatively soon whether or not it can be solved by electronics alone.

One other very promising solution to the data resolution problem outlined above is a "multicell spud instrument." For instance, if we can multiply the oxygen utilization by two orders of magnitude the electronics problems are not nearly so severe. Therefore, if we were to use 100 specimens instead of 1, we would have a signal 100 times as easy to measure. But instrument package weight and size would obviously suffer considerably. The penalty here, we estimate, might be a factor of 10 so that for a 100 cell package it might weigh about 10 times our present one-cell breadboard. Thus, a total package weight of approximately 20 pounds might be expected. This, we recognize, is probably an undesirable solution for some ongoing programs although the great advantages of a multicell instrument might indeed be very useful for other space applications. We intend, as a matter of fact, to submit in the near future a proposal requesting that the present contract be extended and that additional funds be provided so that we can investigate the development of a multicell instrument.

C. Progress

Our calendar time progress has been acceptable and, with the exception of the unresolved major problem outlined above, the program is on schedule. Because of the problems the effort expended, however, is greater than anticipated and costs have been greater than our budget estimates. It is premature to say that additional funds will be required to complete the present effort satisfactorily. However, present indications are that this is the case.

III. PLANS FOR THE COMING PERIOD

Complete total system performance testing and evaluation of the breadboard instrument will be continued and completed during the coming period. After assurance that all components are performing satisfactorily and that the total system is adequate, we will then perform dynamic testing to assure flight suitability for acceleration and vibration.

Meanwhile, concentrated effort will be applied to a determination of how to achieve the resolution of data required for scientific analysis.